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## An Economic Analysis of "Piggyback" Transportation

By

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Transportation coordination, i. e., two or more types of haulage utilized in a unified service, has taken place in the past and characterizes to an extent the American transportation system today. One type which is attracting considerable attention today is the movement of truck trailers on railroad flat cars, the so-called "piggyback" service. "Piggyback" operations have been carried out by a few railroads since the 1920's, but following World War II this coordination procedure has become increasingly important.

A number of transportation officials state that this innovation may be the outstanding development in transportation during the second half of the twentieth century. Some feel "piggyback" may be the means by which the antagonism and bitterness between railroads and motor carriers will be partially diminished. Others contend it will be the device wedding railroads and trucks into a state of matrimony from which both will gain—and from which the community also will benefit.

Some, however, have not been convinced of the possible advantages of this technique of moving goods to destination, expressing hesitancy and skepticism concerning the development. The fear exists that piggyback movements may be a Pandora's box of danger which, when opened, will destroy railroad revenues, threaten the operating authority of motor carriers, and work to the disadvantage of thousands of communities and shippers throughout the land. Numerous perplexing and new issues thus arise with the utilization of trailer-on-flat-car transport. Will it be an improvement in the American transportation system or will it create

more difficulties than gains? What is the economic feasibility and implication of this much debated development in transportation?

### PIGGYBACK—WHAT IS IT?

The description, trailer-on-flat-car movement, notes the distinguishing characteristic of "piggyback" transportation. Truck-trailers are driven by truck-tractors to the loading platforms of shippers where they are loaded and sealed. They are then driven to the trailer-yards of the railroad. The trailers may be loaded immediately on flat cars or parked in a terminal area preparatory to loading. In most instances the trailers are backed up a portable or stationary ramp by a tractor-unit onto a string of specially modified flat cars. Folding bridge plates enable the trailers to be pushed over a string of cars for loading of end cars first. Some suggestions have been made for the placing of trailers on flat cars by giant cranes or fork-lift tractors. At present, however, "circus" or end loading is the typical operation.

After placement on the cars, trailer wheels are chocked and tie-down chains applied. Jacks are raised to hold part of the trailer weight, taking an estimated 60 per cent of the weight from the tires.<sup>1</sup> This process of securing the units can be performed quickly, usually taking only 5 or 6 minutes. The cars are then switched to regularly scheduled trains or become part of a special trailer-train to destination. After the intercity haul, the flat cars are shunted to an unloading area equipped with ramps similar to those at point of origin. The supporting and locking devices are removed; then the trailers are pulled down the ramps and delivered to consignees for unloading by truck-tractors.

Over 20 railroads are presently engaged in truck-rail operations, including the Santa Fe; B & O; Chicago & Eastern Illinois; Burlington; North Western; Chicago Great Western; Erie; MKT; New

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1. *Railway Freight Traffic*, Vol. III, No. 1 (January, 1955), p. 25.

Haven; Pennsylvania; Southern Pacific; and Union Pacific. The services are offered by carriers in all parts of the country except the South, though the L & N plans to begin piggyback operations early in August, 1955.

There are several varieties of ventures underway, the majority of the rail carriers furnishing a wholly rail-controlled movement of LCL and truckload freight with railroad bills of lading, railroad equipment, and rail rates generally competitive to those of motor truck concerns. These rates are on named commodities and, hence, are not markedly different in manner of quotation from those on all-rail or all-motor shipments. Some railroads, on the other hand, notably the Great Western, MKT, New Haven, and Pennsylvania, offer a cooperative piggyback venture with common motor carriers either on a per-trailer charge, joint-rate basis, or with the use of substituted freight directories. Some truck-trailer undertakings such as those of the New Haven and the Chicago and Eastern Illinois are available to all purchasers of transportation, both common and private carriers. Railroads engaging in a cooperative operation with motor carriers currently have the largest volume of piggyback traffic. The all-rail ventures have had un auspicious beginnings with only a relatively few trailers transported. Yet this business may be more permanent and dependable over the long run than the immediate interchange of trailers with motor carriers. The "per trailer" charges and substituted directory procedures of joint service, furthermore, have led to uncertainty in the minds of many traffic officials, for here is a development which violates many of the rate principles of differential pricing so widely utilized in the transportation industry.

#### PIGGYBACK PROFITABILITY— MOTOR CARRIERS

While there are a number of factors to be taken into account in an evaluation of truck-rail transport, a critical question for both railroad and motor carrier management in determining piggyback policy relates to expected profitability. Motor truck operators as rational businessmen will be interested in moving trailers on flat cars only if piggyback intercity costs are somewhat less than usual over-the-road outlays. The profit issue before motor carrier managers thus is how do piggyback costs compare with regular line-haul expenses?

Numerous difficulties make an answer to this question incomplete and tentative. A partial analysis nevertheless suggests what additional investigation is necessary to develop more firm conclusions. One difficulty stems from the fact that readily available cost data do not coincide with the cost standard needed for this analysis. Motor carrier cost information published by the ICC and American Trucking Associations contain a wide variety of useful data, but in each instance the figures are not exactly relevant for the problem at hand. Motor truck op-

erators must have available an accurate estimate of the over-the-road expenses which would be avoided if trailers were transported by rail flat cars between two points. Individual companies seeking to decide whether to engage in a joint piggyback undertaking thus will find it necessary to construct their own cost picture of these avoided costs.

Another difficulty complicating the formulation of an accurate cost picture is the definitional confusion which exists in describing transportation costs. Directly avoided costs are sometimes called direct, prime, or out-of-pocket expense. These are costs which are incurred on behalf of a particular service or class of service and which consequently can be assigned directly to that specific undertaking. Yet cost studies of the Interstate Commerce Commission use the term out-of-pocket costs to include (1) directly-assigned costs of a particular unit of service and (2) common expenses which also vary with changes in the level of traffic.<sup>2</sup> This definition, practically synonymous with the economists' variable cost concept, is useful, but in the piggyback question motor carrier managers are interested only in costs which will be eliminated if truck-rail service is utilized.

While special costs studies are necessary before

2. Explanation of the Development of Motor Carrier Costs with Statement as to their Meaning and Significance, Statement 4725, Bureau of Accounts and Cost Findings, ICC, Washington, D. C., pp. 2-3.

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definite answers can be given, an examination of readily obtained data offers some useful insights. Average total expenses per vehicle-mile, for example, vary widely by regions in the country, ranging from about 50 cents in the South to approximately 77 cents in the New England area.<sup>3</sup> A similar pattern, of course, is portrayed in data on transportation, maintenance, and operating taxes per vehicle-mile. Interestingly enough, in the New England, Middle Atlantic, and Central regions, where piggyback has received its greatest impetus, total costs per vehicle-mile are the highest. Perhaps also it is significant that in the South, where relatively little interest in piggyback has existed, relatively low costs per vehicle-mile characterize operations.

These data, then, suggest, as is well known, that motor carrier costs vary from region to region, and between carriers, which in turn indicates there will be considerable variation in the extent of motor carrier interest in piggyback, depending upon individual carrier and region cost levels. High-cost companies and regions in an effort to reduce over-the-road outlays may find piggyback a real cost-saving opportunity.

Other information approximates more closely the cost data needed to make an accurate appraisal of the situation in which motor carriers become interested in piggyback service. Out-of-pocket line-haul cost figures are derived by Interstate Commerce Commission cost analysts through separation of total expenses (operating costs, rents, and taxes) according to line-haul, pick-up and delivery, terminal platform, billing and collecting functions.<sup>4</sup> The allocated expenses, as mentioned above, include both (1) costs which can be directly assigned to each respective service and (2) common costs which vary with changes in the level of traffic. Most of the common costs variable with traffic probably would continue with piggyback movement of freight. Thus we still lack a measure of line-haul costs directly avoided if piggyback haulage is utilized.

Nevertheless these data enable us to estimate roughly the needed cost standard. Out-of-pocket line-haul costs in 1950 for selected groups of Southern, East-South, and North-South carriers were on the average 23.5, 24.7, and 22.7 cents per vehicle-mile respectively.<sup>5</sup> These costs adjusted by a price index suggested by the Bureau of Cost Finding and Accounts, ICC, result in costs for 1952 of 26.3, 29.2, and 27.0 cents per vehicle-mile respectively.<sup>6</sup> More recent Interstate Commerce Commission cost studies

indicate out-of-pocket line-haul costs per vehicle-mile at about the same levels. A study of 29 class I common carriers of general freight in the Southwestern region for 1953 indicates an average of 26.1 cents per vehicle-mile.<sup>7</sup> A similar study for the same year involving 75 class I carriers in the Middlewest shows out-of-the-pocket line-haul costs of 27.3 cents per vehicle-mile.<sup>8</sup> These figures, which are somewhat greater than actual directly assigned costs of moving a motor vehicle down the highway, suggest these latter costs in 1953 perhaps ranged between 20-25 cents per vehicle-mile.

An attempt to calculate the avoided line-haul expenses if truck-rail transport were utilized, drawn from 1950 figures in the Southern Motor Carrier Cost Study, indicates average directly assigned costs per vehicle-mile in 1950 of about 20 or 21 cents for trucks operating on South, East-South, North-South routes.<sup>9</sup> Adjusted for 1952 prices, the costs for 1952 are estimated to be between 22 and 25 cents per vehicle-mile in the noted territories.

These figures compare fairly closely with other estimates of directly assigned over-the-road outlays. A recent report on piggyback, for example, describing 1954 costs, stated "The national average of direct over-the-road costs is approximately 25-30 cents per trailer mile."<sup>10</sup> Another student of truck-rail developments estimated that it cost in 1954 about 25 cents per truck-mile to move a loaded vehicle over the highway, with expenses of about 17-18 cents per truck-mile for movement of empty vehicles.<sup>11</sup>

These figures, and the others cited above, suggest a cost guide to motor truck managers in evaluating the possibility of piggyback haulage. T-O-F-C charges to motor carriers must be somewhat less than the estimated costs of driving the vehicle over the road, or about 20 cents per vehicle-mile, before cost-savings of sufficient amount are present. This apparently is the approximate standard of judgment, for the Pennsylvania truck-rail service between New York and Chicago is based on charges of 21 cents per trailer-mile for loads with gross weights of 32,500 pounds and 24 cents for loads with gross weights of 32,500-42,500 pounds.<sup>12</sup> The Chicago Great Western piggyback undertaking on Chicago-Kansas City and Chicago-St. Paul routes is based on charges to motor truck companies of approximately 19 or 20 cents per vehicle-mile.<sup>13</sup> Even with this information, individual motor truck concerns will find it necessary to determine their own

3. Derived from information in *Financial and Operating Statistics, Class I Motor Carriers of Property*, Summary Tables, 1953-1954, American Trucking Associations, Washington, D. C.

4. *Southern Motor Carrier Cost Study—Year 1950*, Statement 2-53, Bureau of Accounts and Cost Findings, ICC, Washington, D. C., April, 1953.

5. Derived from *Southern Motor Carrier Cost Study—Year 1950*, Statement 2-53, Bureau of Accounts and Cost Findings, ICC, Washington, D. C., pp. 32, 34, 132, 134, 232, 234.

6. *Ibid.* p. 1.

7. *Cost Study of Class I Motor Carriers of General Freight in the Southwest Territory*, 1953, Statement 6-54, Bureau of Accounts and Cost Findings, ICC, Washington, D. C., p. 6.

8. *Cost Study of Class I Motor Carriers of General Freight in the Middle West Territory*, 1953, Statement 5-54, Bureau of Accounts and Cost Findings, ICC, Washington, D. C., p. 7.

9. Derived from data in *Southern Motor Carriers Cost Study—Year 1950*, Statement 2-53, Bureau of Accounts and Cost Findings, ICC, Washington, D. C., pp. 24, 86, 124, 186, 224, 286.

10. "Economics of 'Highway Trailer on Flat Car' Service," American Railway Engineering Association, *Bulletin*, Vol. 56, No. 518, November, 1954, p. 340.

11. *Traffic World*, Vol. 93, No. 9 (February 27, 1954), p. 26.

12. *Modern Railroads*, Vol. 10, No. 2 (February, 1955), p. 53.

13. Derived from information in Divisions Sheet 300B, Chicago GW, Effective November, 1954, and *Railway Guide*, January, 1955, pp. 1011-1012.

cost pattern in order to make a factual decision about piggyback service.

### PIGGYBACK PROFITABILITY—RAILROADS

Railroad managers likewise have the crucial question of profitability before them in an analysis of piggyback transportation. Their analysis is complicated by the difficulty of determining applicable rail costs of piggyback movements, for as is well known, railroads are characterized by a high degree of common costs. With many railroad expense items arising from the operation of the business as a whole, and hence not directly assignable to particular units of service, the railroad manager faces a complex problem in formulating a satisfactory cost standard. Some understanding, however, can be achieved through revenue comparisons and cost studies of the Interstate Commerce Commission. Use of these cost studies must be qualified, for they refer to national or regional average levels of costs, which may understate or overstate the actual costs of individual railroads. Individual railroads interested in trailer-rail transport, consequently, will find it necessary to make their own investigations in order to frame an accurate decision.

With a lack of cost information bearing directly on the problem, the Commission in a relatively early investigation of piggyback profitability approached the matter obliquely, comparing average revenues per loaded car-mile of trailer traffic with earnings of regular rail shipments.

The average revenue per loaded-car mile under the arrangement approved in the related proceeding (truck-rail service), based on average revenue of \$76.53 per car . . . was 17.39 cents. The average gross weight of the loaded and empty trailers carried was 45,667 pounds or 22.83 tons per car. The average freight revenue of the Great Western in 1953 was 17.84 cents per loaded-car mile, and the average freight-service operating expense for all freight was 12.03 cents per loaded-car mile. The average load of all freight in that year was 21.61 tons per car and the average haul of all freight 305.8 miles.<sup>14</sup>

The Commission concluded that piggyback average revenues per car-mile were about the same as average revenues for all freight and undoubtedly noted that piggyback earnings were somewhat in excess of average operating expenses per loaded car-mile.<sup>15</sup> The regulatory body also described factors which would tend to reduce trailer-rail costs below those for regular rail shipments, such as less terminal handling, less empty movement, and less clerical and accounting expense for the railroad in the particular piggyback enterprise in question.<sup>16</sup>

In a recent examiner's decision concerning the profitableness of all-rail, truck-flat-car haulage,

other comparisons were made between prospective revenues from piggyback and regular carload movement of a wide variety of selected items.<sup>17</sup> The piggyback rates involved in the proceeding were generally competitive with all-motor-carrier rates on the same items shipped between the same cities. Among the evidence analyzed was a Pennsylvania Railroad exhibit comparing earnings from transportation of a large grouping of manufactured goods on New York-Pittsburgh, Philadelphia-Pittsburgh, Chicago-Philadelphia, and New York-Chicago routes. This exhibit indicated that of approximately 550 comparisons all, except 27, would result in greater revenues per car-mile and per car with truck-rail haulage than with existing carload rates and minimum weights.<sup>18</sup> The study indicated earnings, based on applicable minimum weights, ranging from 25 to 86.4 cents per car-mile and from \$227.76 to \$786 per car between Chicago and New York under carload rates, in contrast to ranges of 54 to 93.2 cents per car-mile and \$500 to \$848 per car with proposed piggyback rates between the same points.<sup>19</sup> Between Chicago and Pittsburgh the earnings varied from \$236 to \$817.60 per car and from 50.4 to 175 cents per car-mile with the proposed piggyback rates as compared with \$176.10 to \$441 per car and 37.6 and 94.4 cents per car-mile under existing carload rates.<sup>20</sup> Average earnings for the selected items on the Chicago-Pittsburgh routes were 59 cents per car-mile for carload freight and 74 cents for proposed piggyback traffic.<sup>21</sup>

It must be remembered that these comparisons were based on minimum weights of regular carload traffic. With average loadings well above these minimums, carload freight actually would have higher car-mile and per car earnings than those indicated above. Nevertheless, as the examiner concluded, "The respondents' evidence, which is not rebutted, indicates generally that the proposed rates are compensatory."<sup>22</sup>

In the case of the joint truck-rail service of the Pennsylvania between New York and Chicago, revenue contrasts are satisfactory but less favorable. Rail earnings in the joint arrangement vary from 36.6 to 42.1 cents per car-mile,<sup>23</sup> which is below the lower limit of the all-rail piggyback earnings but above minimum car-mile earnings in carload traffic. The advantage of a joint piggyback enterprise even with lower car-mile earnings results from anticipated immediately large volumes of traffic received from participating motor carriers which has not characterized all-rail piggyback service.

18. Derived from *Comparison of Rates and Revenues, Trailer on Flat Car and Carload Pa Tariff ICC 3360*, Exhibit in I & S Docket 6214, Witness Talbot.

19. *Ibid.*, pp. 7-13.

20. *Ibid.*, pp. 5-6.

21. *Ibid.*, pp. 5-6.

22. *Trailers on Flat Cars—Eastern Territory*, I & S Docket 6214, *op. cit.*, p. 8.

23. *Modern Railroads*, Vol. 10, No. 2 (February, 1955), p. 53.

14. *Motor-Rail-Motor Traffic in East and Midwest*, 219 ICC 245, p. 267, (1936).

15. *Ibid.*, p. 267.

16. *Ibid.*, pp. 267-268.

17. *Trailers on Flat Cars—Eastern Territory*, I & S Docket 6214, April, 1955.

In interpreting these figures and those cited above in the Pennsylvania all-rail piggyback operation, it is necessary to remember that these data are calculated with two trailers transported on 75 foot flat cars. At present this special equipment is used only by a relatively few railroads, which means car-mile and per car earnings of other carriers for the same distances are about half the levels shown here. Furthermore, if the Pennsylvania utilized flat cars which could handle only one trailer, profitability would be considerably altered.

The lack of a suitable cost standard hampers discussion of piggyback profitability, but available cost data leads to some tentative conclusions. Out-of-pocket rail costs as used by ICC cost analysts include (1) directly assignable costs to particular units of service and (2) common expenses which vary directly with changes in volume of traffic over a relatively long period of time.<sup>24</sup> While expenses which do not vary in direct proportion to output are excluded from the definition, a relatively long-run time period is used in the concept. Out-of-pocket costs as here used thus include a large portion of total expenses—about 76 per cent of fully distributed expenses. These data, then, are a fairly complete cost criteria.

As recent rail cost material indicates, Eastern railroads during 1953 in flat car service, at average loading of 20 tons, experienced out-of-pocket costs of about 38, 35, and 30 cents per car-mile for distances of 400, 500, and 1000 miles respectively.<sup>25</sup> Pennsylvania all-rail piggyback prospective earnings per car-mile as noted above are in excess of these out-of-pocket costs and are even above the tabulated fully distributed expenses. On the Chicago-Pittsburgh route, for example, a Pennsylvania rail distance of 468 miles, the lower limit of earnings, 50.4 cents per car-mile, exceed both the average out-of-pocket cost at 500 miles of 35.0 cents per car-mile and the fully distributed costs of 45.8 cents per car-mile.<sup>26</sup> The average car-mile earnings for the items presented in the above Pennsylvania exhibit for Chicago-Pittsburgh traffic amounted to 74 cents per car-mile, well above the cost figures indicated in the study footnoted below.

On the Chicago-New York route, a distance of 910 miles via Pennsylvania, a similar pattern is demonstrated. Out-of-pocket costs and fully distributed costs in 1953 for Eastern railroads were 29.6 and 39.2 cents per car-mile respectively for distances of 1,000 miles,<sup>27</sup> in comparison to a lower limit of piggyback car-mile earnings of 54 cents per car-mile.

Comparison with car-mile earnings from joint motor-rail piggyback operations, though less favor-

able, indicates a compensatory service at distances of over 400 miles. At estimated car-mile earnings of approximately 40 cents, based on two trailers per flat car at about 20 cents per trailer mile, out-of-pocket costs are covered for distances above 400 miles. At distances of 1,000 miles, the spread between out-of-pocket costs and estimated earnings is great enough that fully distributed costs would be approximately covered.<sup>28</sup> The cost data cited above also suggest that at estimated earnings of 40 cents per car-mile, piggyback operations would more than cover regular flat car out-of-pocket costs for carriers in the South and West. With hauls of less than 400 miles, however, the earnings differential undoubtedly would disappear.

There are a number of factors, furthermore, as the Commission concluded in 1936, which tend to result in lower costs in piggyback service than with regular flat-car operations. The impact of these cost-saving features in the problem at hand should be taken into account. One factor tending to reduce costs is less empty movement of cars. Commission studies in 1949 indicated that the ratio of empty to loaded car-miles with flat car equipment averaged 48 per cent in the East and 62 per cent in the South.<sup>29</sup> For every 100 miles of loaded car operation the carriers in the East experienced 48 miles of empty flat car movement. An official of the Great Western, on the other hand, estimated that Great Western ratio of empty to loaded car-miles with piggyback transport is about one-third.<sup>30</sup> Furthermore, with joint motor-rail operations, railroads often receive revenue for hauling empty trailers, making empty movements produce revenues.

Terminal handling of piggyback freight also is a less costly operation particularly with LCL traffic because of trailer unit loading and unloading of shipments. An additional terminal costs-saving results from less switching per car in the make up of trains, for often ten or twelve cars are switched at once in piggyback operations. With some ventures such as that of the CGW, loading and unloading of trailers is carried out by motor carrier employees, considerably reducing rail terminal expenses. Any modest reduction in terminal costs will have an effect upon total costs, for terminal expenses are a significant portion of aggregate outlays. With Eastern railroads in 1953, for example, terminal costs with average boxcar traffic at 500 mile distances were about 26-29 per cent of total costs.<sup>31</sup>

The most publicized basis of less costs in truck-rail operation is the decline in loss and damage to freight. MKT officials note, for example, that "our

28. *Ibid.*, pp. 18, 38, 48.

24. Explanation of Rail Cost Finding Procedures and Principles Relating to the Use of Costs, ICC Statement 4-54, Bureau of Accounts and Cost Findings, Washington, D. C., November, 1954, pp. 1-3.

25. Derived from data in Railroad Carload Cost Scales By Territories As of January, 1953, Statement 4-53, Bureau of Accounts and Cost Findings, ICC, Washington, D. C., pp. 18, 38, 48.

26. *Ibid.*, pp. 18, 38, 48.

27. *Ibid.*, pp. 18, 38, 48.

29. Railroad Carload Cost Scales By Territories As of January 1, 1953, Statement 4-53, Bureau of Accounts and Cost Findings, ICC, Washington, D. C., p. 5.

30. Correspondence with Mr. R. G. Hawkinson, Freight Traffic Manager, CGW, dated May 19, 1955.

31. Derived from Rail Carload Cost Scales by Territories as of January 1, 1953, Statement 4-53, Bureau of Accounts and Cost Findings, ICC, Washington, D. C., Tables 1 and 2, pp. 16 and 57.



## JUNE ATLANTA AREA ECONOMIC INDICATORS

ITEM	June 1955	May 1955	% Change	June 1954	% Change
<b>EMPLOYMENT</b>					
Job Insurance (Unemployment)					
Payments -----	\$238,925	\$242,241	-1.4	\$384,406	-37.8
Job Insurance Claimants † -----	3,571	3,896	-8.3	5,950	-40.0
Total Non-Agricultural Employment ---	314,150	309,750	+1.4	298,200	+5.3
Manufacturing Employment -----	87,400	86,400	+1.2	78,250	+11.7
Average Weekly Earnings,					
Factory Workers -----	\$65.93	\$68.14*	-3.2	\$62.25	+5.9
Average Weekly Hours,					
Factory Workers -----	40.2	40.8*	-1.5	39.4	+2.0
Number Help Wanted Ads -----	9,181	11,328	-19.0	6,106	+50.4
<b>CONSTRUCTION</b>					
Number Building Permits,					
City of Atlanta -----	984	1,077	-8.6	919	+7.1
Value Building Permits					
City of Atlanta -----	\$6,458,461	\$6,253,622	+3.3	\$27,012,307	-239.1
Employees in Contract Construction ---	20,250	19,400*	+4.4	18,050	+12.2
<b>FINANCIAL</b>					
Bank Debits (Millions) -----	\$1,427.8	\$1,426.6	+0.1	\$1,232.0	+15.9
Total Deposits (Millions)					
(Last Wednesday) -----	\$999.8	\$1,001.8	-0.2	\$988.7	+1.1
<b>POSTAL \$</b>					
Postal Receipts -----	\$1,456,834	\$1,479,283	-1.5	\$1,385,261	+5.2
Poundage 2nd Class Mail -----	1,325,310	1,455,590	-8.9	1,151,263	+15.1
<b>OTHER</b>					
Department Store Sales Index					
(Adjusted) (1947-49=100) -----	136	137*	-0.7	130*	+4.6
Retail Food Price Index					
(1947-49=100) -----	111.0	111.1	-0.1	114.7	-3.2
Number Telephones in Service -----	260,157	259,519	+0.2	247,754	+5.0

\*Revised

†City of Atlanta only.

\*Claimants include both the unemployed and those with job attachments, but working short hours.

Sources: All data on employment, unemployment, hours, and earnings: Employment Security Agency, Georgia Department of Labor; Number Help Wanted Ads: Atlanta Newspapers, Inc.; Building permits data: Office of the Building Inspector, Atlanta, Georgia; Financial data: Board of Governors, Federal Reserve System; Postal data: Atlanta Post Office; Retail Food Price Index: U. S. Department of Labor; Department Store Sales and Stocks Indexes: Federal Reserve Bank of Atlanta and Board of Governors, Federal Reserve System; Telephones in Service: Southern Bell Telephone and Telegraph Company.



## JANUARY THROUGH JUNE, 1954 and 1955

1955	1954	ITEM	% Change
54,586	39,357	Number Help Wanted Ads -----	+38.7
18,483	15,442	No. Construction Employees * -----	+19.7
\$8,289.5	\$7,487.3	Bank Debits (Millions) -----	+10.7
N.A.	N.A.	Department Store Stocks ** -----	+9.0
5,719	5,245	Number of Building Permits City of Atlanta -----	+9.0
84,833	78,433	No. Manufacturing Employees * -----	+8.2
8,378,330	7,774,402	Poundage 2nd Class Mail Atlanta Post Office -----	+7.8
\$66.25	\$62.38	Average Weekly Earnings, Factory Workers * -----	+6.2
\$8,671,983	\$8,214,627	Postal Receipts Atlanta Post Office -----	+5.6
N.A.	N.A.	Department Store Sales Based on Dollar Amounts ** -----	+5.0
260,157	247,754	Telephones in Service ** -----	+5.0
306,783	296,683	Total Non-Agricultural Employment * -----	+3.4
40.4	39.6	Average Weekly Hours, Factory Workers * -----	+2.0
\$999.8	\$988.7	Total Deposits (Millions) ** -----	+1.1
111.0	114.7	Retail Food Price Index (June) -----	-3.2
\$40,548,039	\$50,692,241†	Value Building Permits, City of Atlanta -----	-20.0
27,416	34,426	Job Insurance Claimants -----	-20.4

†Special ruling permitted construction of \$20,500,000 Grady Hospital addition without permit. If included, total above is \$71,192,241, and the change becomes minus 43.0%.  
 \*Average Month  
 \*\*End of Period  
 N. A.—Not Available  
 Sources: Same as Page 6.

experience to date has been entirely damage free," though during the period in question only 477 trailers had been handled in MKT piggyback service.<sup>32</sup> Chicago & NW spokesmen have stated their piggyback enterprise has produced unexpected and substantial savings in the first three months of operation without a single claim for damage.<sup>33</sup> The Pennsylvania in the first six months of operation moved 1,913 trailers, receiving 16 claims for damage.<sup>34</sup>

The ratio of claim payments per \$100 of freight revenue in this service amounts to \$0.488 and if we eliminate one large claim the ratio per \$100 of freight revenue would have been \$0.108 . . . By comparison, the road's ratio for movement of ordinary freight cars in 1954 was \$1.68.<sup>35</sup>

These records are perhaps too tentative and incomplete to allow firm conclusions; nevertheless, it is likely that less damage and loss will result, partly because of greater security and support given shipments in piggyback service.

While the above comparisons are approximate and crude, they indicate several tentative conclusions concerning the profitability of piggyback undertakings. All-rail service with two trailers per flat car, having sufficient volume, should result in earnings sufficient to meet both out-of-pocket and fully distributed expenses. Joint rail-motor enterprises with two trailers per flat car should meet at least a cost criteria which includes 76 per cent of fully distributed expenses. These conclusions apply generally to rail operations in all parts of the country. The information also suggests that piggyback undertakings which involve only one trailer per flat car, with car-mile earnings of about 20-25 cents per car-mile, may not be profitable according to a relatively long run out-of-pocket cost standard. A more short run out-of-pocket cost pattern, however, can be formulated to act as a guide for gauging the profitableness of piggyback service. Some railroads furnishing a truck flat-car service with one trailer per car apparently have used bare incremental costs as a guide, concluding that the additional costs of handling more cars are small. The pressure of competition and unwillingness to purchase new equipment, may force a greater use of an incremental cost standard in evaluating the compensatory nature of a proposed T-O-F-C undertaking.

#### PIGGYBACK AND THE PUBLIC INTEREST

In studying the significance of piggyback haulage for shippers and the community-at-large, it is necessary to understand the role of transportation generally in the American economy. This understanding forms a guide or yardstick by which to judge the public-interest value of the proposed innovation. Basic to the modern American economic order is a category of activity or structure which economists have variously designated as forces of

production, industrial arts, technology, or the machine process. Whatever the generic category may be called, the industries of the economy, along with such seemingly diverse units as farms, households, and retail stores, are organized into an integrated and unified mechanism or process for production and consumption of goods and services. The parts of the whole process fit into an endless and interlocking sequence, each performing specialized operations which are understandable only in terms of its relationships with other divisions of the entire pattern. Each part of the over-all organization receives its supplies, labor, and equipment from other units, and in turn transfers its output to segments which make up still further phases of the process. Interdependence, then, and not self-sufficiency, is a primary characteristic of twentieth-century industrial environment.

One requisite for continuation of the life-process of society is a constant and regular flow of goods between the pieces of the integrated production mechanism. A cessation or irregularity of flow of goods from such a relatively small unit as a ball-bearing factory, for example, may be felt by the companies furnishing it steel, factories producing machines using the bearing, and perhaps by households of many industrial and transportation workers. Reserves of goods do not exist in the economy in sufficient amount to allow for long stoppages, the result being that halts in the system quickly lead to chaos and decline in output throughout much of industry. Transportation facilities and personnel thus form vitally necessary connective links joining the literally millions of sub-parts into a tremendously productive process. It is elementary that without modern transportation, the American economy would become that of the self-sufficient, small-scale society of 200 years ago. Modern transportation is essential, then, in maintaining a going, functioning industrial system, for it is the physical means of communication and linkage of productive units separated by distance.

In evaluating the public-interest aspects of piggyback service, then, we must judge the innovation by the need for effective transportation. Is piggyback transportation a more satisfactory way of getting goods from one point to another in the nation's productive apparatus? In terms of time in transit, truck-rail movement in contrast to all-rail shipment of LCL merchandise traffic undoubtedly is a marked improvement. In comparison with all-motor traffic, however, this advantage apparently does not exist in any great degree. On hauls of over 400 to 500 miles average time in transit with expedited piggyback undertakings would be about the same as that of all-motor service. But the dispersion around average time very likely would be less, particularly in areas with poor weather conditions and congested highways. As one traffic man-

32. *Railway Freight Traffic*, Vol. III, No. 4 (April, 1955), p. 58.

33. *Traffic World*, Vol. 94, No. 1 (July 3, 1954), p. 20.

34. *Railway Freight Traffic*, Vol. III, No. 4 (April, 1955), op. cit., p. 59.

35. *Ibid.*, p. 59.

36. *Railway Freight Traffic*, Vol. III, No. 1 (January, 1955), p. 35.

ager has stated in discussing the advantages of piggyback operations, "You can depend on scheduled arrival times, trailers not held up by highway accidents, traffic jams, detours, or bad weather."<sup>36</sup> Motor-rail enterprise may mean some, but not remarkable, improvement in dependability of service.

A possible truck-rail advantage lies in the thesis that piggyback undertakings blend the service advantages of both forms of transport. Railroads with an ability to move large volumes of freight between major centers at low costs handle the line-haul phase, while motor carriers particularly able to shift goods in feeder movements engage in that function. Thus the two forms of transportation are coordinated, each doing what it can do best—making a more efficient transportation system. Less community resources, consequently, may be required to perform the same transportation tasks. This is a proposition which needs further study before definite conclusions can be reached, for the whole question of service or "inherent" advantages is one clouded with confusion, complexity, and self-interest.

Another gain to shippers and the community at large from truck-flat-car undertakings results from the increase of transport facilities made available to thousands of commercial and business establishments not located on railroad sidings. Many of these shippers obtain a satisfactory transport alternative at rates and service approximately equal to those of all-motor operations, increasing the competition in these transportation markets. Other advantages accruing to shippers and the community are less loss and damage to freight and a diversion of trailers from congested highways to under-utilized railroad facilities. The latter suggestion, however, is easily exaggerated, for piggyback in the foreseeable future will not be a universal service between all points in the country. All that can be said is some diversion of trailers results, and to the extent that it takes place, other things being equal, there is less highway congestion.

It is difficult to draw conclusions concerning the question whether piggyback service brings about an improvement in the physical processes of moving goods from one point to another. Some motor carrier spokesmen contend that there is not any gain to shippers in service or rates and that the operation simply increases the discrimination between large and small commercial centers.<sup>37</sup> It seems from the above discussion, however, that some gain to the community will ensue from piggyback under certain circumstances, with increase in dependability, alternative means of shipping goods, less damage to freight, and possibilities in coordinating the service advantages of two forms of trans-

portation. These gains are not extraordinary in extent nor universal in their application, but probably exist in sufficient supply to warrant community encouragement of this innovation in transportation methods.

These gains which tend to foster a more efficient productive mechanism, however, may be hampered by considerations of industry status and tradition. Some railroad managers, for example, have dismissed piggyback transport as a most unusual procedure which does not fit accepted ways of railroading. It is a procedure which may require change in pricing and operating policies, upsetting long-standing methods of handling freight and of determining rates. Some motor carrier officials, on the other hand, have fought even joint arrangements for movement of trailers via flat cars, fearing that motor carriers may become minor units in the national transportation system.

This latter possible obstacle to piggyback haulage particularly is one which stems from an institutional pattern in which physical facilities of truck and rail are owned by different business enterprises, generating rivalry and antagonism. Perhaps this obstacle could be resolved by formation of integrated companies or by government ownership and operation which would result in centralized control of both truck and rail operations. Coordination as in piggyback probably then could be established without fear of decline in status and industry position.

Apparently such marked change in the institutional framework, however, is not necessary, for many motor carriers and railroads through joint tariffs or substituted freight service directories have brought about a successful coordination of truck with rail—leaving motor carriers and railroads as basically independent entities. This development perhaps has a larger significance for the community than is found in actual utilization of piggyback methods. It illustrates the extraordinary fluidity and mobility of American institutional patterns to adjust to technical change. Enough institutional adjustment characteristically has taken place, even with obstructions present, to accommodate society to a changing technology. Such prosaic things as joint motor-rail tariffs and substituted freight directories thus foster coordination of trucks and railroads without drastic upheaval in the ownership patterns of the transportation industry.

The drag of tradition, likewise, in the face of growing competition and increased managerial imagination, appears to be a declining threat to the use of this innovation. Many railroad managers, as our recent experience indicates, are experimenting with audacity and courage in the application of piggyback service to the transportation business.

37. *Traffic World*. Vol. 91, No. 1 (July 3, 1954), p. 18.

# The Characteristics of Operations Research

by

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Much has been written—and more has been said—about operations research during the past few years. As yet, there is no clear agreement on what operations research is and no very clear statement of what it does.

Many of the articles appearing in the *Journal of the Operations Research Society of America* and in *Management Science* and many of the talks given before Operations Research Society Institute of Management Sciences, and before other organizations give the impression that operations research is some new and quite rarefied branch of mathematics. At one and the same time, many of the articles and many of the talks claim as triumphs for operations research, work of types that has long been done successfully by industrial engineers, quality control statisticians, economic analysts, management engineers, and others.

This apparent dichotomy suggests that operations research has some affinity for mathematics and something in common with the other and better established management sciences. It sometimes leads to the conclusion that operations research is really industrial engineering or statistical quality control or some other management science but that its practitioners are masters of more highly developed and more highly refined mathematical techniques.

Actually, there are two characteristics of operations research, neither of which having much to do with technique, that serve to distinguish it from the other management sciences. These will be discussed under the headings "Whole-System Approach" and "Use of Mixed Teams." And the position can be defended, with no great fear of successful contradiction, that any claims made to these two characteristics by other management sciences are made in imitation of operations research.

## WHOLE-SYSTEM APPROACH

Before discussing the whole-system approach, it is advisable to point out that some of the best known examples of operations research do not conform to this characteristic. Most of these well known examples are drawn from wartime experience, when the motto of most operations researchers had to be, "Do the best you can with what you have—and in a hurry." And they did very well indeed, achieving major improvements in many military operations.

Today, however, when operations research is much more mature and is given an opportunity to

affect the inputs as well as the existing elements of an operation, more and more of the outstanding examples of the art involve analysis of whole—and sometimes very large and complex—organizations and systems. Stated another way, operations research makes no effort to compete directly with those who have specialized in the analysis of production operations, sales operations, accounting operations, purchasing operations, or investment operations. Rather it seeks to assist management by synthesizing the analysis of all of these elements, whether the analysis has been done by operations researchers or others, in order to arrive at the recommendation (or set of alternative recommendations) for decision that will best serve the interests of the whole organization.

This is a very ambitious undertaking. It requires a high level of understanding of the whole operation or organization. Achievement of this understanding takes time and hard work—getting to know people, gathering data on various aspects of the organization, developing models of suboperations and fitting them into larger and larger models of larger and larger segments, until final synthesis is achieved.

Furthermore, work at the level of the whole organization requires a somewhat different attitude on the part of management than does work within some segment of the organization. Every organization has its secrets; every organization is subject to constraints, some real and some fictitious, that are comprehended fully only at the topmost levels; every organization has personalities that must be respected or reckoned with. Knowledge of these hidden or little known "facts of life" can be very important to understanding an organization. This is not to imply that the operations research group is successful to the extent that it is "in" on all the internal gossip and politics of an organization, but it is to imply that the management using an operations research group must have sufficient confidence in the group to be willing to provide it with access to all of the data needed to make a complete analysis.

Another important aspect of working at the level of the whole organization is the necessity for considerable latitude in the interpretation of problems. Very frequently, a problem as stated is a symptom of a disorder; the real problem may be quite far removed, organizationally speaking, from the symptom. This means that the operations research group must have the freedom to seek out cause-effect relationships. If it is restricted to the

\*Dr. McCloskey with F. N. Trefethen edited the book, *Operations Research For Management*, which was recently published by Johns Hopkins University.

problem as given, or if it is confined to one segment of the organization, then this pursuit of causes of disorder may become impossible.

The "classic" example of the whole-system approach is the work of Thornthwaite at Seabrook Farms.<sup>1</sup> He was engaged as a consultant on problems of supplemental irrigation. At the same time, the Seabrook management was wrestling with a severe sociological problem induced by the necessity for using transient labor during the harvest cycle.

In Thornthwaite's work, it was essential that he understand the particulars of the growth cycle at Seabrook. He suspected that this understanding would provide some leads to the solution of the sociological problem. In effect, he ignored both supplemental irrigation and sociology and developed a **planting** schedule for Seabrook. He did this because his study of the whole system had shown that the uncertainties, the unpredictables, all went back to the planting cycle. Once the planting operations had been put on schedule, supplemental irrigation became relatively simple and the sociological problem disappeared—because the need for transient labor had disappeared. Furthermore, the planting schedule not only regularized the harvest schedule, but the processing and freezing schedule as well. This in turn led to the elimination of canning of items that are more profitable in frozen form and minimized the quality-control problem.

There may be those who would claim that Thornthwaite was "lucky." Those who know operations research and have seen how valid and how powerful the whole-system approach can be, know that Thornthwaite was "lucky" only to the extent that he was given the opportunity, by a discerning management, to regard the whole of the Seabrook complex as a single problem. From there on it was hard work—observing operations, collecting and analyzing data, conducting experiments, and proceeding by successive approximations to a final synthesis—reinforced by sound scientific training and a fertile imagination.

#### USE OF MIXED TEAMS

The other major or different characteristic of operations research is the use of integrated, mixed teams. This statement requires some amplification.

Mixed teams are becoming increasingly commonplace in developmental research. Thus, physicists, mathematicians, and electronic engineers team very effectively in the development and design of complex equipment like radar systems and computing machines. They have found that the team is, in effect, more than the sum of its parts, and that the complexity of such equipment and the know-how required for its development transcends the capability of all but the most exceptional individuals, no matter how well trained.

With no intent to deride the efforts and

<sup>1</sup> C. W. Thornthwaite, "Operations Research in Agriculture," in J. F. McCloskey and F. N. Trefethen, eds., *Operations Research for Management*, Baltimore, Johns Hopkins Press, 1954, pp. 368-80.

achievements of the scientists and engineers who have joined forces to produce the electronic marvels of our times, one can quite easily demonstrate that the understanding necessary to their achievements is quite simple when compared with the understanding required for achievement of new organizational designs and improvements in operating methods. In research on organizations and operations, there are many more variables to be brought under control and there is always the human element with which to cope.

Thus, it becomes essential that each problem be analyzed carefully and that the operations researchers put on the job be ones whose backgrounds and knowledge of research techniques are fitted to the task at hand. Full realization of this "ideal" is possible, of course, only in very large groups. Thus, organizations the size of the RAND Corporation or the Operations Research Office of The Johns Hopkins University can have thirty or more academic specialties represented on their staffs. It should be emphasized here that this broad sampling of the academic spectrum has not come about because someone thinks it's "a good idea." Rather, it has come about because the problems handled by these organizations have been such as to necessitate employment of a diversity of specialists.

Smaller operations research groups can approximate the flexibility of larger groups by selecting specialists in fields likely to be needed most frequently in the solution of the problems of the organization being served by the group, and then supplementing their efforts by the judicious use of other specialists on a consultant basis. This means, of course, that some fraction of the budget of the operations research group must be reserved for this purpose.

Experience has shown that physical scientists and applied mathematicians or mathematical statisticians are likely to be more frequently required for the handling of operations research problems. But many of the outstanding practitioners are engineers—mechanical, civil, electrical, industrial, etc.—philosophers of science, economists, psychologists, political scientists, biologists, and so on.

The work of the Operations Research Office on the assignment of Negro manpower in the Army is, in some ways, a "classic" example of the use of mixed teams.<sup>2</sup> The physical scientists who were available to handle this problem when it was presented to the Operations Research Office were rather at a loss where to begin. A literature foreign to their training and experience had to be searched and it was apparent right from the start that research techniques, also foreign to their training and experience, would be required.

ORO promptly recruited an educator, a psychologist, an anthropologist, and a social historian to work on the problem. One of the military his-

<sup>2</sup> A. H. Hausrath, "Utilization of Negro Manpower in the Army," in McCloskey and Trefethen, op. cit., pp. 352-67.

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torians already on the staff was added to the group. And funds were made available for a demographic study, a public opinion survey type of study, and a "critical incidents" study, each to be carried out by reputable research organizations specializing in the use of the techniques. Stated another way, the conceptual knowledge and research tools and techniques of this group of new staff members were more important to the accomplishment of the task at hand than was any ability to speak knowledgeably to the question, "What is operations research?" The "old hands" on the staff were able to serve as consultants at critical times in order to make sure that the canons of operations research were adhered to by the "greenhorns."

In this case and in many others, operations research has proved equal to the solution of extremely difficult management problems because great care was exercised in fitting the team to the problem. In other words, there was no preconception that operations research is some set of specific techniques to which a problem must be fitted in order to qualify as an operations research problem. It is reasonable to conclude that much of the power of this relatively new management tool is traceable to the diversity of specialties that can be marshalled to its use—provided the specialists learn to work together as genuinely integrated mixed teams.

In a very real sense, learning to work in integrated, mixed teams is the most difficult task confronting a neophyte in operations research. Even those who share the ability to communicate with each other in mathematical terms must develop an appreciation of each other's conceptual knowledge and approach to model-making. Furthermore, those versed in mathematics must develop an appreciation for the verbal logic of the non-mathematicians, while the latter must open their own minds to the power of the mathematically based logics of the physical sciences.

As one whose academic training was in history, the writer can attest to the difficulty, not only

of learning to communicate with physical scientists and mathematicians on a two-way basis, but also to the difficulty of breaking down the age-old condescensions of one group of specialists toward another.

The problem of communication is made still more difficult by the necessity for learning the (usually non-academic) language of the client of the operations research group. Failure to communicate properly with fellow researchers makes the job more difficult; failure to communicate results to the client in terms he can understand and act on with confidence can be fatal!

#### CONCLUSION

Operations research offers, then, a relatively new and very powerful tool to management. It shares many common characteristics with other management sciences but has unique features that set it apart.

The two distinguishing characteristics that have been set forth here—the whole-system approach and the use of mixed teams—have special significance in another direction. Because the operations research group must achieve an understanding of the whole organization it is serving and because its members must learn to work together in integrated teams, operations research cannot be expected to yield big returns, overnight, for an organization. As a matter of fact, experience has shown that as much as three to five years may be required before a group achieves genuine maturity and can begin to produce results on a steady, continuous basis.

This, in turn, is one of the strongest arguments for having an operations research group continuously available to an organization, rather than on a consulting basis. Increasingly, the integral group is becoming the pattern of operations research in this country. And the long period of learning has likewise been accepted, possibly because, even in their infancy, most operations research groups have more than paid their way for the organizations using them.